5-2016

Warmer Temperatures on American Kestrel (Falco sparverius) Breeding Grounds Associated with Earlier Laying and Successful Reproduction

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WARMER TEMPERATURES ON AMERICAN KESTREL (FALCO SPARVERIUS) BREEDING GROUNDS ASSOCIATED WITH EARLIER LAYING AND SUCCESSFUL REPRODUCTION

By

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A Master's Thesis Submitted to the Faculty of

Montclair State University

In Partial Fulfillment of the Requirements

For the Degree of

Master of Science in Biology with Concentrations in Ecology and Evolution

May 2016

College of Science and Mathematics

Biology Department

Thesis Committee:

[redacted]

[redacted]

[redacted]

Abstract

The American Kestrel (*Falco sparverius*) recently has been discovered to be in decline and the reason is still unknown. Many studies have shown climate's effect on migratory birds, but the relationship between climate and kestrel ecology has received little attention. This study sought to determine whether the climate in northwestern New Jersey and kestrel reproductive efforts have changed over the course of 20 years as well as determining whether these two factors are related. Monthly temperature, rainfall, and snowfall data were obtained from online databases. Breeding variables, including percentage of nest boxes used, clutch and brood size, percentage of successful attempts, and mean number of fledglings per successful attempt (MFPSA), were obtained from a nest box program established in 1995. Correlative statistics and a principal component analysis were conducted. Weather variables changed little through the study period. Regarding breeding variables, earlier laying dates were strongly correlated with larger clutch sizes. Of the climate variables, temperature exhibited the most variability and had the strongest relationships with breeding variables, warmer temperatures being associated with higher reproductive success. Weather did not seem to influence how many kestrels reached the breeding grounds, but once the birds arrived, temperature may have had a significant impact on when the birds lay their eggs, which has a positive relationship to clutch size, brood size, and therefore the number of fledglings that live to banding age, the standard measure of reproductive success.

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Acknowledgements

I would like to thank Dr. John Smallwood for his advising and establishment of the New Jersey kestrel nest box program, as well as generating the 20 year's worth of extensive breeding data. I also thank my thesis committee, Dr. Scott Kight and Dr. Lisa Hazard for their advisement. All volunteers who aided in gathering the kestrel reproductive data also deserve a thank you as well as Montclair State University, where this study was conducted.

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The American Kestrel (*Falco sparverius*) is North America's smallest falcon and also one of its most widespread (Smallwood and Bird 2002). Kestrel numbers in the United States and Canada have been declining (Smallwood and Bird 2002). The decline of the kestrel is only a recent observation, but research into the past has shown that the decline began about 40 years ago in the mid to late 1960s (Smallwood et al. 2009). The North American Breeding Bird Survey indicated that the decline in kestrel numbers, survey wide, has continued from 2007 to 2015 (Sauer et al. 2015). Locations such as Pennsylvania and New York also have shown significant declines in nest box use, down a quarter of what it once was (Smallwood et al. 2009).

Kestrels are a crucial part of North America's ecosystem. They are an integral member of the food web and generally eat small arthropods and mammals (Smallwood and Bird 2002), including many that are considered pests. Kestrels are beneficial to humans in other ways as well, being used extensively for research due to their success with captive breeding (Bird 1982). These birds are also involved in public education on falcons and birds of prey.

Death caused by humans is a frequently occurring phenomenon in many species and can be hypothesized as a cause of decline. Human involvement can range from road collisions and hunting to electrocution from utility wires or attacks from domestic animals. Of all research being done on direct persecution and anecdotal deaths of these birds, it was found that contact with humans was insignificant for these birds and often biased because those are the deaths that are most often marked and tracked (Smallwood and Bird 2002).

Construction, urbanization, and habitat loss are other targets of research because these causes have been shown to negatively affect many other organisms. Deforestation, which has recently increased for agricultural use of land and other economic services, may in fact be beneficial for kestrels because the birds inhabit open, grassy areas for easier prey locating (Smallwood and Bird 2002). In Spain, it was found that flat topography and the presence of cereal crops were good predictors of where to find Lesser Kestrels (*Falco naumanni)* (Bustamante 1997).

Competition with other species also has been studied as a possible explanation for the decline in kestrel populations. Occasionally, kestrels compete for space and resources with Eastern Screech Owls (*Megascops asio*), European Starlings (*Sturnus vulgaris*), Eastern Bluebirds (*Sialia sialis*), and eastern gray squirrels (*Sciurus carolinensis*) (Smallwood and Bird 2002). Predation pressure also could influence the kestrel population. Fire ants and snakes occasionally prey on young nestlings and even eggs, creating noticeable differences in the adult population after only a few generations (Smallwood and Bird 2002). Other larger hawks and falcons occasionally prey on adult kestrels, but generally find other sources of food (Smallwood and Bird 2002). The population of Cooper's Hawks (*Accipiter cooperii)*, a known predator of the American Kestrel, have recently increased and has been suggested as a cause of kestrel decline, but was shown not to be by Smallwood et al. (2009). Migrant birds can also face stronger competition for food from year-round residents (Berthold et al. 1998). The young birds present in New Jersey almost always migrate, while adults use weather patterns to determine when and whether or not to migrate, so young kestrels are more likely to be impacted by this competition (Smallwood and Bird 2002). More northern bird populations, such as those present in Canada, are fully migratory, using photoperiod as their indicator (Smallwood and Bird 2002).

Global climate change has already shown to contribute to a number of changes in various species' life history and reproduction trends (Heath et al. 2012) and cannot be ignored as a potential cause of decline for American Kestrels. Research on global climate change is still in the beginning stages, but many relationships between weather and its effect on birds have already been found (for example, Heath et al. 2012, Sokolov and Payevsky 1998, Both et al. 2009).

Major effects of global climate change include an increase in the global temperature as well as an increasing occurrence of extreme events involving temperature, water and wind (Intergovernmental Panel on Climate Change 2014). Warmer temperatures can cause birds to shorten migration distances, causing less south to north movement and vice versa (Heath et al. 2012). Climate change may also affect a number of different species of migratory birds' ability to coordinate arrival time to the breeding ground with important seasonal events, such as leaf-out, because of unrelated weather changes on their wintering grounds (Both et al. 2009). The climate may also influence when resources are available and at their peak on the breeding ground (Both et al. 2009). Kestrels currently arrive on breeding grounds when both food and potential mates are available. This is necessary for successful breeding and young raising and situations resulting in insufficient food or habitat could significantly damage the population.

The majority of studies on birds and climate change have been conducted on passerines and in locations such as Europe and neighboring continents. Although we can often assume similar results for other migratory birds in similar latitudinal locations, few data are available on the relationship between weather and American Kestrel ecology. Research has not identified a single cause of decline for this species (Smallwood and Bird 2002), and climate has not been examined as a potential cause of decline for kestrels in the northeastern United States.

This study used breeding data from a kestrel nest box program established in 1995 in northwestern New Jersey and weather data from stations monitored by the National Oceanic and Atmospheric Administration. The objectives of this study were (1) to determine whether the climate of northwestern New Jersey has been changing over the course of 20 years (1996-2015), (2) describe kestrel breeding parameters and population trends over this period, and (3) determine whether kestrel breeding is related to local climate.

Methods

Reproductive Data

Between 1995 and 1997, approximately 100 American Kestrel nest boxes were erected throughout Sussex (centered on 41°11' N, 74°38' W) and Warren County (centered on 40°47' N, 75°04' W), New Jersey, a common breeding ground for the birds. This area was primarily used for agriculture, with fragmented forest plots throughout (Smallwood 2016). These nest boxes were placed mainly on utility poles, trees, and barns along roads to allow for easy access to the boxes. The nest boxes had internal dimensions of 20 × 23 cm with a height of 34 cm (Smallwood 2016) and have been up and monitored throughout each breeding season (March through August) since 1995.

Each nest box was visited beginning in March or April for the minimal amount of time needed to collect all data (generally under 10 minutes) to minimize human related effects on the adults or nestlings, even though human handling has shown to have little negative effect (Smallwood 2016). From April to May, most visits occurred every 21 to 28 days in an attempt to discover breeding during the laying stage. At the first visitation of the year, nest boxes were cleared of any debris and a layer of pine wood chip bedding put down. At each consecutive visit, nests and eggs of European Starlings and other invasive species were disposed of and replaced with a layer of fresh pine wood chips. At subsequent visits, all invasive species were evicted. Native species were left undisturbed.

When adult kestrels were found in the nest, they were caught by covering up the entrance hole with a net, opening the side of the nest box, and catching them by hand. The adults were banded with a U.S.G.S aluminum leg band if not banded already. We also marked them with a vinyl-coated nylon patagial tag, which has shown not to impact breeding success (Smallwood and Natale 1998, Varland et al. 2007, Smallwood 2016). Nestlings were visited before fledging at approximately 18-22 days old to band as well.

At each visit, all pertinent data were collected, including the number of eggs, chicks, and the presence of adults. When a nest box was found to contain kestrel eggs, more visits were scheduled to collect data on clutch size, hatching date, and brood size and a final visit was scheduled to band nestlings. Kestrels are known to lay one egg every two days and incubation lasts about 30 days (Smallwood and Bird 2002), so laying date (herein to mean date of clutch initiation) was determined either by counting back using the number of eggs present in an incomplete clutch or, when clutches were already complete when discovered, by counting back both incubation and laying days from hatching. A successful breeding attempt was defined as an attempt for which at least one nestling was banded. Banded young are considered fledged. Laying date, mean clutch size, mean brood size (mean number of chicks), mean number fledglings per successful attempt (henceforth referred to as MFPSA), and the percentage of available nest boxes that were used by kestrels were determined.

Weather Data

To determine climate and weather patterns throughout the 20-year time frame, I used two online databases to determine monthly temperatures, rainfall, and snowfall. There was a distinction between rainfall and snowfall in months where snowfall was present (October through April). The National Oceanic and Atmospheric Administration (NOAA) (http://www.noaa.gov/) and Rutgers Monthly Climatological Summaries (http://climate.rutgers.edu/stateclim/) was the source of this information. Five weather stations nearest to clusters of the nest boxes were chosen. Sussex County stations included the Andover Aeroflex Airport (41°0' N, 74°44' W), Sussex NW (41°13' N, 74°39' W) and Sussex Airport (41°12' N, 74°37' W). Warren County stations included Belvidere Bridge (40°49' N, 75°5' W) and Phillipsburg Easton (located in Pennsylvania; 40°41' N, 75°12' W). Phillipsburg Easton weather data from 2000-2003 were obtained from the Pennsylvania State Climate Office (http://climate.psu.edu/). Because all data were so similar as well as quite close in geographical location, I used mean values to create a single set of weather data values to analyze.

Statistical Analyses

I used means for each year for each variable for 20 years, 1996-2015. I then tested for normality using the Shapiro-Wilk method. Much of the data differed significantly from normality, so I performed the nonparametric Spearman correlation analysis for all variables. I analyzed the weather data, including the variables of temperature, rainfall, and snowfall, by month during the primary kestrel breeding season (March through August). I then pooled the data for months outside the breeding season into autumn (September through November) and winter (December through February). I analyzed the seasons using the kestrel-breeding year from September through August. For example, September 1997 would be considered autumn of the 1998 breeding year.

I analyzed breeding data with variables including laying date, mean clutch size, mean brood size, MFPSA, percentage of active nest boxes used, and percentage of successful breeding attempts, compared to year as well as laying date. I transformed laying dates into the Julian date, 1 to 365 or 366, taking into account leap years. I then analyzed weather and breeding data together. All *P*-values are two-tailed.

I then subjected the 20 weather variables to a principal components analysis. The weather variables included the mean temperature, mean rainfall, and mean snowfall for the breeding months as well as the two seasons. The first three principal components accounted for almost half of the variability (Table 1). The first principal component, which accounted for about 21% of the variability, represented warmer temperatures and less snowfall (Table 2). I tested data for normality with a Shapiro-Wilk test. No significant deviations were found, so I used a Pearson correlation test to compare the first three principal components to the kestrel breeding variables.

Results

With the establishment of the kestrel nest box program in northwestern New Jersey in 1995, the percentage of nest boxes used initially increased, but subsequently has declined (Figure 1). From 1996-2015, there were no significant changes in any of the kestrel breeding variables (Table3). With respect to the laying date, early clutches were significantly larger (Figure 2). No other breeding variable was significantly correlated with laying date (Table 4).

From 1996-2015, I found trends in increasing April and November temperatures and increases in June and August rainfall (Table 5). April temperatures were positively correlated with both clutch size and brood size (Figure 3). Increased June temperatures also had a significant positive correlation with brood size and MFPSA (Figure 4), and percentage of successful attempts (r=0.477, P=0.034). Autumn temperatures correlated positively with the next breeding season's clutch and brood size (Figure 5).

April snowfall was negatively correlated with clutch size (r=-0.483, P=0.031), brood size (r=-0.612, P=0.004), and percentage of successful attempts (r=-0.624, P=0.003). The amount of autumn snow also was negatively correlated with brood size (r=-0.462, P=0.040), MFPSA (r=-0.456, P=0.043), and percentage of successful attempts (Figure 6). Neither April or autumn snowfall had changed significantly over the years.

Of all of the weather variables, April temperature had the most influence on principal component 1 (Table 2). The first principal component was negatively correlated with laying date (Table 6), indicating that warm temperatures were associated with early laying. This analysis showed that temperature and snowfall during as well as preceding the breeding season are strongly correlated to kestrel reproduction.

Discussion

This study was an assessment of recent weather conditions and breeding trends for American Kestrels in northwestern New Jersey. These data show a strong relationship between warmer temperatures and the breeding variables including clutch initiation date and number of eggs laid, which subsequently increased the number of fledglings per season. Temperature accounted for the largest variability in the first principal component and that component was strongly correlated with more eggs leading to larger brood sizes and more fledglings. Breeding variables did not change throughout the 20-year span, which suggests that the kestrel decline is not due to reproductive failure of this population. Fledglings are an important variable for following the future population dynamics for kestrels because they have the potential to contribute to the population in the next season.

Earlier laying dates and larger clutches associated with temperature were shown in this study as well as a number of previous studies. Warmer temperatures have been shown to induce earlier spring migration and arrival to breeding grounds in passerine bird species (Mason 1995, Sparks 1999, Coppack and Both 2002). Sokolov and Payevsky (1998) found that all 10 of the passerine species they studied tended to migrate one to two weeks earlier than even the decade before, and therefore would begin breeding earlier as well. Northern Goshawks (*Accipiter gentilis)* in Finland showed that with higher temperatures in spring and early summer they would produce more offspring. This was attributed to better body condition upon arrival to the breeding grounds because of milder winters (Lehikoinen et al. 2013). American Kestrels also have shown an increase in earlier migration as well as subsequent earlier clutch initiation, laying eggs up to 30 days earlier than in 1987, leading to higher overall reproductive success (Heath et al. 2012). Our results add to this, indicating trends of earlier laying with larger clutches when temperatures are warmer, although neither weather nor breeding variables have changed significantly over the past two decades in our study area. Also, we did not include any migration variables in this study, making laying date the earliest evidence we have of kestrel presence during the breeding season.

Heath et al. (2012) found upon analyzing banding records and Christmas Bird Counts over the course of 50 years in Idaho, that total kestrel migration distances have significantly decreased and the birds were wintering farther north. If birds can migrate shorter distances, this can provide them with physiological, energetic, and thermoregulatory benefits, arriving back to the breeding grounds in better physical condition (Heath et al. 2012). Our results show that increasing snowfall was negatively correlated with breeding variables, possibly indicating that autumn snowfall could induce migration in this partially migratory population. Most kestrels in our area migrate in September or early October (Smallwood and Bird 2002), and snowfall during this time in our area can induce migration as opposed to overwintering in the area. On the other hand, birds that would likely overwinter without migrating may be at a disadvantage when autumn snow occurs because if the snow persists, they may be forced to migrate to acquire adequate food. Arriving on the wintering grounds later than other individuals often leads to obtaining lower quality habitat because the high quality sites may have already been taken (Smallwood 1988). This can lead to further disadvantages in the upcoming breeding season. Warmer winter temperatures and less snow could mean that kestrels would not migrate, which may have a positive correlation with the next breeding season's laying date as well a clutch size.

Altering the timing of arrival back to the breeding ground also has potential to lead to asynchrony, where breeding and peak prey availability no longer occur concurrently, causing less successful overall reproduction (Post et al. 2001). Both et al. (2006) found that higher springtime temperatures changed a number of species' breeding timeline and threw off the food peak during the season. Our results do not suggest that this is occurring in kestrels because the breeding variables remained unchanged. However, migratory behavior and prey availability were not available for our analyses.

Although our results indicate positive correlations among larger clutch sizes, earlier laying dates and warmer temperatures, the analysis of weather data does not indicate that any monthly or seasonal temperatures significantly changed throughout the course of the 20-year study. The time frame may not be long enough to see a difference, or it may be that the climate in northwestern New Jersey is not changing much. However, the results could imply that as global temperature increases, as predicted by global climate change, and kestrel habitat is impacted, they still may be reproductively successful or even thrive.

Temperature is only one factor affecting the kestrel reproductive cycle, so if only temperature increases, our data suggest that the birds may thrive. However, climate change has cascading effects likely to impact other factors, both biotic and abiotic. Future research should include studying how kestrels are affected by more frequent and intense storm surges and how the kestrel's main food sources are impacted by changes in weather. By studying this geographical region further, we may be able to determine what will cause the birds to migrate. Predicted warming weather trends may actually benefit kestrels, so the cause of kestrel decline has still not been identified by the current study. Increases in predators of kestrels has been hypothesized as a likely reason for decline, so more in-depth future research should be conducted in that field to continue the search for an answer.

Smallwood et al. (2009) reported that kestrels in North America were in decline, but that birds present on the breeding grounds were in good condition, suggesting that the cause of decline was occurring along migration paths or wintering grounds (Smallwood et al. 2009). Future studies may also include surveying kestrels on their wintering grounds to help determine where and how far they are going, and whether or not the kestrels that breed in our study area are relocating to a different area or if they are prematurely dying.

The principal component analysis conducted here showed strong associations between temperature and various measures of reproductive output. However, there is no evidence that weather has any association with whether or not kestrels return to the study breeding ground, yet when they do show up, weather may very affect how successfully they breed.

Conclusion

Although the analysis of both weather and breeding data alone showed few significant changes from 1996 to 2015, these data indicate that there is a strong association between kestrel reproductive output on the breeding ground and temperature throughout their breeding season. April temperatures did increase significantly during this period and had a significant relationship with kestrel breeding during a key breeding month. Warmer temperatures may influence earlier laying as well as increased clutch size, also positively correlating with the number of brood and fledglings. American Kestrels should continue to be monitored throughout North America to assess their population trends. These observations will help us to better understand trends in bird behavior and phenology and their relationship to global climate change.

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Table 1: Eigenvalues from the principal components analysis of 20 weather variables, northwestern New Jersey, 1996-2015. Variables included mean temperature, mean rainfall, and mean snowfall for the months of March through August, and pooled data for the season of autumn (September, October, November) and winter (December, January, February).

		Variation Explained	
Principal Component	**Eigenvalue**	**Proportion**	**Cumulative**
1	4.188	0.209	0.209
2	3.005	0.150	0.360
3	2.472	0.124	0.483

Table 2: Eigenvectors from the principal component analysis of 20 weather variables, northwestern New Jersey, 1996-2015. Principal component 1 represents warmer temperatures and less snowfall. Principal components 2 and 3 represent less consistent patterns of variables.

	Principal Components		
Original Variable	**1**	**2**	**3**
April Temperature	0.390	-0.087	0.247
Autumn Temperature	0.342	0.079	0.284
July Temperature	0.322	-0.141	-0.015
Winter Temperature	0.321	0.136	-0.277
June Temperature	0.297	-0.300	0.204
March Snowfall	-0.295	-0.155	0.322
March Temperature	0.267	0.304	-0.129
Autumn Snowfall	-0.244	-0.024	0.156
Winter Snowfall	-0.232	-0.234	0.261
April Snowfall	-0.208	0.056	-0.228
August Temperature	0.207	-0.166	0.098
Winter Rainfall	0.190	-0.215	0.279
May Rainfall	0.140	0.256	-0.048
March Rainfall	0.100	-0.341	-0.156
May Temperature	0.081	0.300	-0.003
July Rainfall	-0.073	0.383	0.346
Autumn Rainfall	-0.047	0.291	0.290
August Rainfall	0.030	0.174	0.334
April Rainfall	0.028	0.131	-0.132
June Rainfall	0.016	0.243	0.168

Table 3: Kestrel breeding variables did not change significantly from 1996 to 2015. *P*-values are two-tailed probabilities from Spearman correlation tests. Data are from northwestern New Jersey.

Breeding Variable	**Mean**	**SD**	***P***
Nest Boxes Used (%)	27.6	10.5	0.123
Laying Date (Julian)	123.0	7.4	0.576
Mean Clutch Size	4.6	0.2	0.273
Mean Brood Size	3.3	0.7	0.227
Successful Attempts (%)	74.0	14.5	0.181
MFPSA[1]	3.9	0.4	0.326

[1] Mean number of fledglings per successful attempt.

Table 4: Other than clutch size, kestrel breeding variables were not significantly correlated with laying date. *P*-values are two-tailed probabilities from Spearman correlation tests. Data are from northwestern New Jersey, 1996-2015.

Breeding Variable	***r***	***t***	***P***
Nest Boxes Used (%)	-0.188	-0.81	0.429
Mean Clutch Size	-0.473	-2.28	0.035
Mean Brood Size	-2.668	-1.17	0.257
Successful Attempts (%)	-0.261	-1.15	0.265
MFPSA[1]	-0.232	-1.01	0.326

[1] Mean number of fledglings per successful attempt.

Table 5: Trends in monthly temperature and precipitation in northwestern New Jersey, 1996-2015. *P*-values are two-tailed probabilities from Spearman correlation tests.

	Temperature			**Rainfall**			**Snowfall**		
Month	**Mean (° F)**	**SD**	***P***	**Mean (in.)**	**SD**	***P***	**Mean (in.)**	**SD**	***P***
January	27.2	4.5	0.969	3.4	1.7	0.379	8.9	8.2	0.601
February	29.3	4.9	0.561	2.6	1.5	0.192	10.4	10.4	0.543
March	37.8	4.2	0.698	3.6	1.6	0.530	4.5	4.5	0.601
April[1]	49.4	2.1	0.002	3.7	1.7	0.379	0.9	2.8	0.562
May	59.4	2.9	0.175	4.0	1.8	0.635	-	-	-
June[2]	67.9	2.0	0.207	4.8	2.4	0.008	-	-	-
July	72.5	2.5	0.285	4.6	1.9	0.247	-	-	-
August[2]	71.1	1.9	0.297	5.1	3.3	0.014	-	-	-
September	64.0	2.1	0.175	4.7	3.8	0.726	-	-	-
October	52.6	2.2	0.459	5.1	3.4	0.793	0.3	1.0	0.683
November[1]	42.3	3.1	0.007	2.9	1.1	0.482	0.7	2.1	0.384
December	33.0	4.4	0.698	4.9	2.9	0.254	5.6	5.8	0.876

[1] Mean monthly temperature increased significantly.

[2] Mean monthly rainfall increased significantly.

Table 6: Kestrel breeding was significantly associated with principal component 1, which represents warm temperatures and low amounts of snowfall. Warmer temperatures were related to earlier laying dates, larger numbers of eggs, chicks, and fledglings. *P*-values are two-tailed probabilities from Pearson correlation tests. Data are from kestrel breeding in northwestern New Jersey, 1996-2015.

	PC 1		**PC 2**		**PC 3**	
Breeding Variable	***r***	***P***	***r***	***P***	***r***	***P***
Nest Boxes Used (%)	0.352	0.128	0.044	0.855	-0.267	0.255
Laying Date (Julian)	-0.490	0.028	-0.240	0.307	0.092	0.699
Mean Clutch Size	0.745	0.002	-0.028	0.908	0.076	0.749
Mean Brood Size	0.642	0.002	-0.047	0.843	0.294	0.208
Successful Attempts (%)	0.471	0.036	-0.039	0.871	0.327	0.159
MFPSA[1]	0.609	0.004	0.005	0.985	0.093	0.695

[1] Mean number of fledglings per successful attempt.

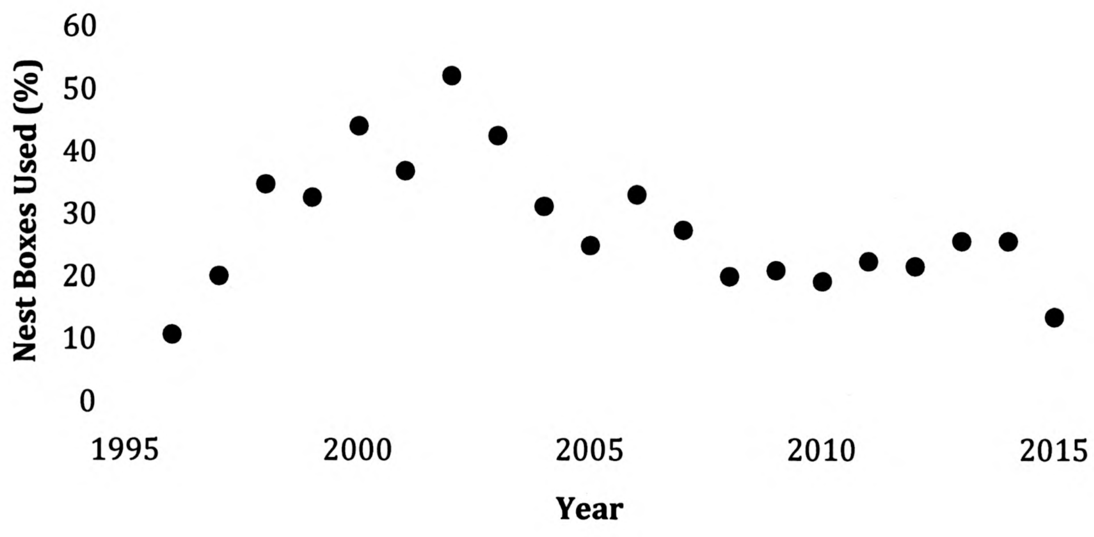

Figure 1: Although kestrels initially responded positively to the introduction of nest boxes in northwestern New Jersey, the population subsequently has been declining. Approximately 100 next boxes were available each year.

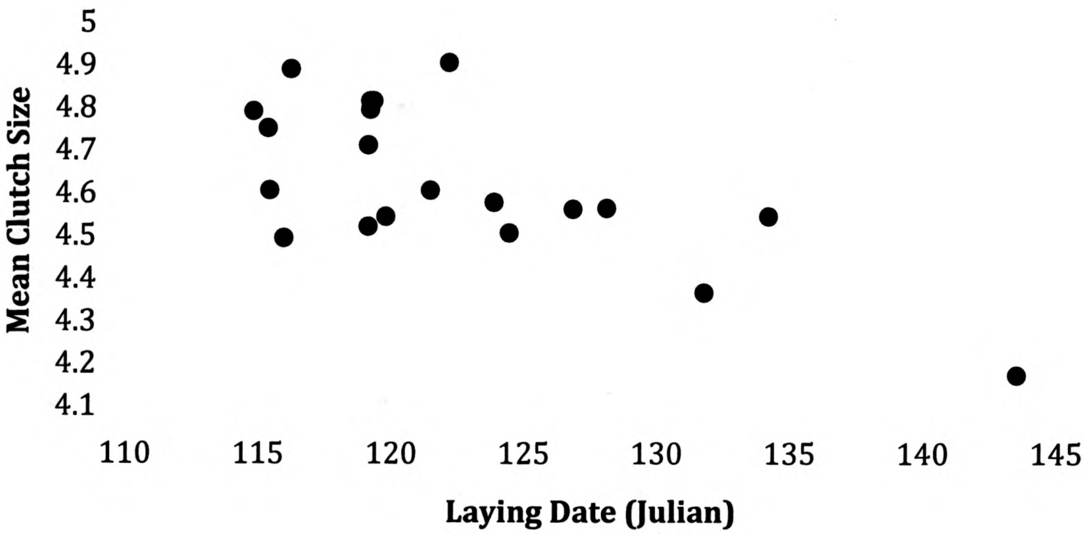

Figure 2: Kestrels laid larger clutches early in the breeding season. Spearman correlation, r=-0.473, P=0.035. Data are from northwestern New Jersey, 1996-2015.

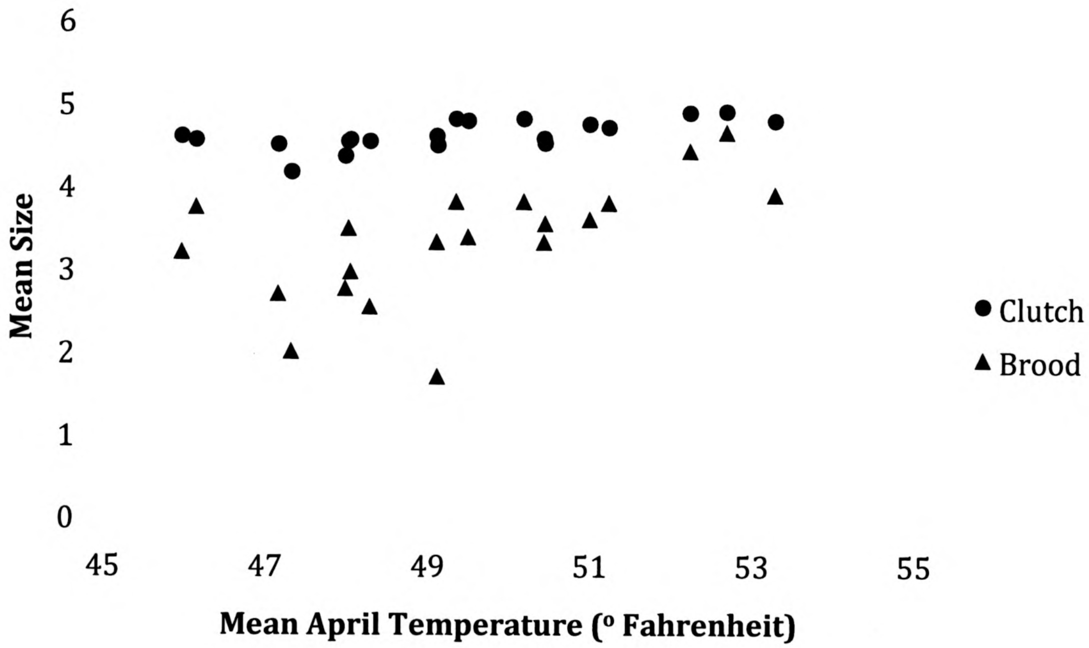

Figure 3: Warmer temperatures in April were associated with larger clutch and brood sizes in kestrels. Spearman correlation, r=0.659, P=0.004, and r=0.679, P<0.001, respectively. Data are from northwestern New Jersey, 1996-2015.

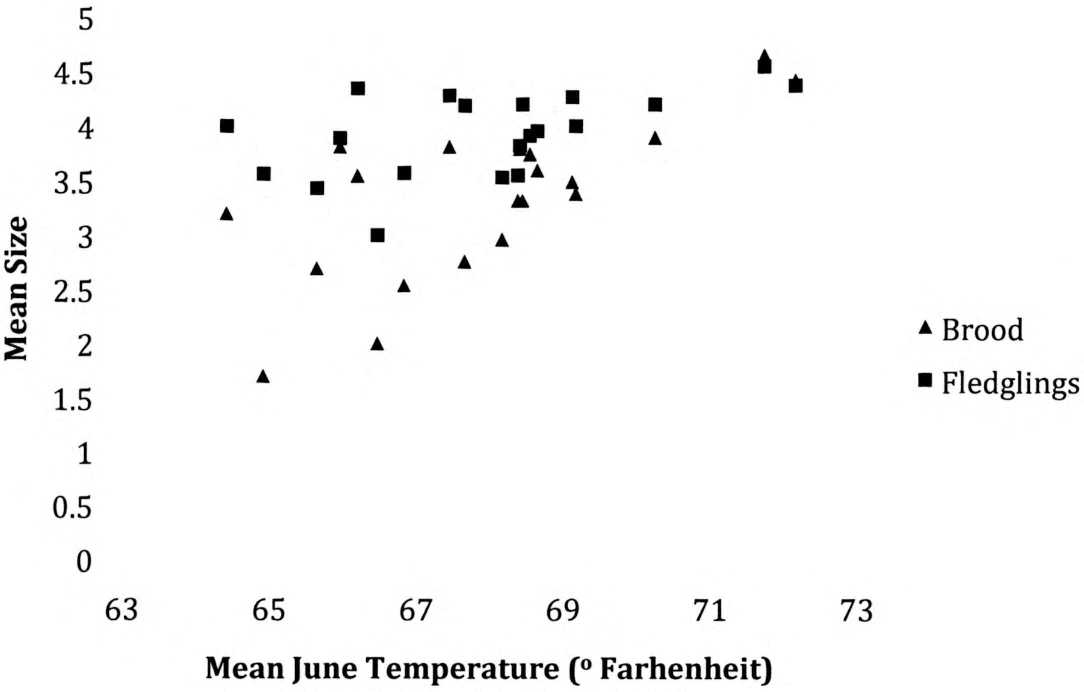

Figure 4: Warmer June temperatures were associated with larger brood and fledgling sizes in kestrels. Broods are number of chicks per all attempts. Fledglings are number of fledglings per successful attempts. Spearman correlation, r=0.626, P=0.003, and r=0.512, P=0.021, respectively. Data are from northwestern New Jersey, 1996-2015.

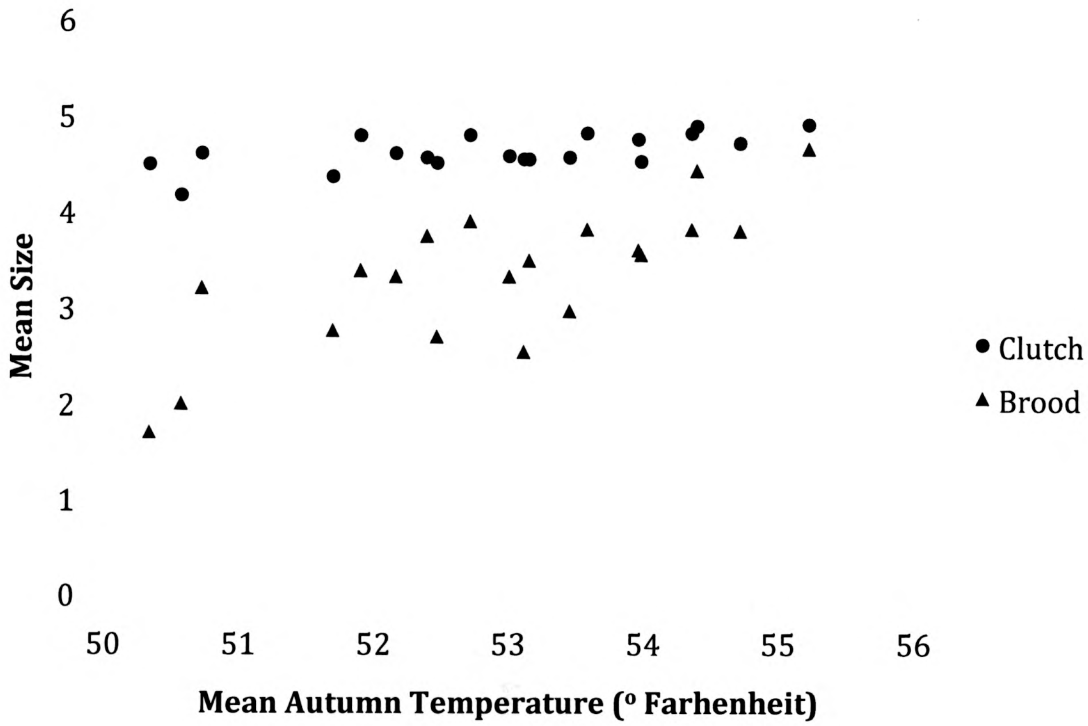

Figure 5: Warm temperatures during the autumn preceding breeding seasons were associated with larger clutch and brood sizes in kestrels. Spearman correlation, r=0.612, P=0.004, and r=0.730, P<0.001, respectively. Data are from northwestern New Jersey, 1996-2015.

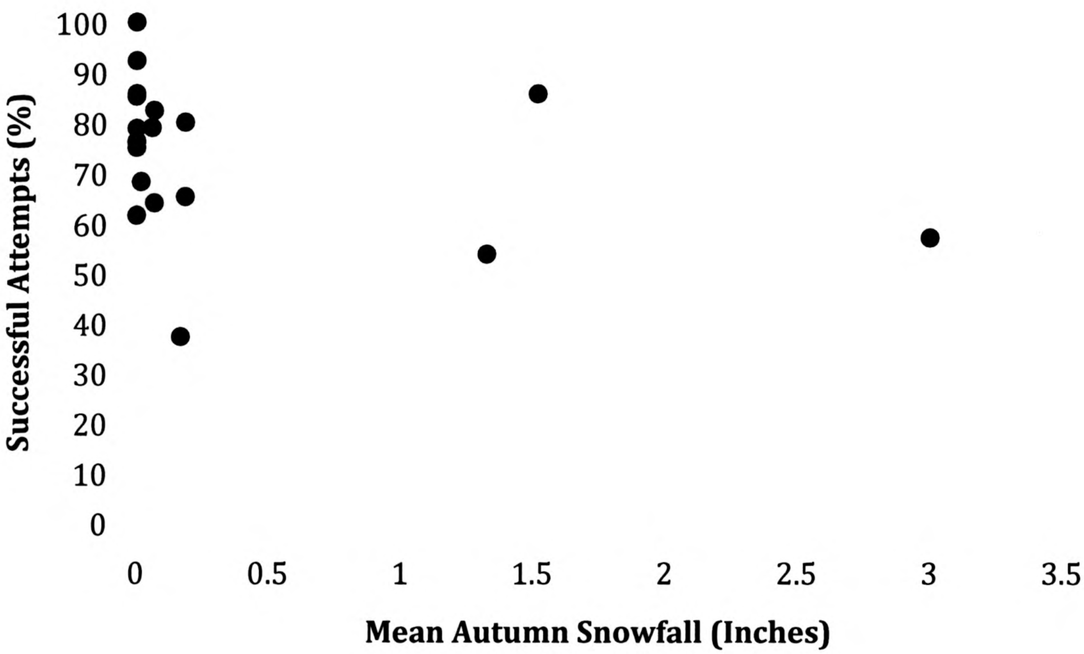

Figure 6: Increased snowfall during the autumn preceding breeding seasons was associated with fewer successful breeding attempts by kestrels. Spearman correlation, r=-0.5706, P=0.009. Data are from northwestern New Jersey, 1996-2015.